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ON AN OCCURRENCE OF CORUNDUM AND DUMORTIERITE IN PEGMATITE IN COLORADO

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Introductory.—The purpose of the writer in the present paper is to record the occurrence of corundum in association with dumortierite and sillimanite in the rôle of igneous minerals in pegmatite, near Canyon City, Colo. The pegmatite dike in question is acid, its mineralogy is that of a granite, and it stands in epidote schist near masses of granite along Grape Creek. Corundum was first noted in the dike by Mr. Eugene Weston, of Canyon City. The occurrence is recorded by J. H. Pratt in the paper cited below.[1] The facts point to the igneous character of the pegmatite dike. It is therefore of interest to find corundum, dumortierite, and sillimanite in it as possible original constituents of such an acid rock. The dike does not show signs of metamorphism.

The complex of rocks appearing at the north end of the Wet Mountains in Colorado, on which the Ordovician and later Paleozoic series rests unconformably, consists largely of schist and gneiss, cut by veins of pegmatite and by diabase dikes. The wall rock in which the corundum-bearing pegmatite vein stands is dark, fine-grained schist. Under the microscope apple-green pleochroic hornblende appears as the most abundant constituent. Quartz is in small grains. The feldspar is deeply kaolinized, with muscovite as an alteration product. Epidote and magnetite are abundant. Apatite and hematite occur sparingly. Dark biotitic granite appears in extensive masses near the locality in question. Microcline, acid plagioclase, quartz, and biotite, with zircon, apatite, magnetite, and secondary hematite, are its constituent minerals.

Occurrence in the field.—The vein of pegmatite is seen on the ridge between the Rocky Mountain Boy and Joker claims on Grape

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[1] J. H. Pratt, "Mineral Resources, Abrasives," *U. S. Geological Survey*, 1901, p. 45; see also *North Carolina Geological Survey*, Vol. I (1905), p. 238.

Creek, seven miles southwest of Canyon City, Colo. The abandoned tunnel of the Rocky Mountain Boy bears N14E from it. The distance from the mine tunnel is about 100 yards. The United States landmark No. 6236 has been cut on the vein at the summit of the ridge. The vein is from 40 to 80 feet wide. It stands vertically in the schist, appearing as a knob where it crosses the divide. It strikes N46E, running down the hillside for some distance on either hand until it is covered by the rock slide of the lower slopes. Two prospect holes have been made on it above the Rocky Mountain Boy. Along the south wall against the schist are stains of copper, malachite, and it is near this wall that the corundum occurs most abundantly.

Macroscopic description.—In hand specimens glassy quartz, in grains an eighth of an inch across, is the most abundant mineral in the pegmatite. The corundum appears to favor association with the quartz. White sugary plagioclase is present, with rarer crystals of pink microcline. Two kinds of mica are prominent, one white, the other black and much more abundant. The plates are at times half an inch across. Muscovite and biotite are indicated by the axial angles. Corundum appears as a local constituent of the vein in hexagonal crystals which are often half an inch in diameter. The mineral is glassy, and of a clear blue color, but not good enough to be of gem quality. The basal cleavage is prominent.

Microscopic description.—Under the microscope quartz, with the minute needles referred to rutile, is seen to be as abundant as are the feldspars taken together. Microcline, and acid plagioclase, probably albite, twinned on the albite law with occasional pericline lamellae, are observed. No carlsbad twins were noted. The highest symmetrical extinctions measured were 9°. Muscovite is unusually prominent. The corundum resembles glassy quartz. Rectangular cleavage cracks parallel to the base are, however, prominent. Negative crystals of hematite are often seen in it. Basal sections give a uniaxial cross without the rings which appear in the field of view when the figure of quartz is examined. Dumortierite occurs in very perfect pointed prisms 1^{mm} in length by 0.03^{mm} in breadth. They are faint blue. At times they make up bundles of radiating needles; occasionally they show a parting parallel to (001). Large, more massive columnar aggregates are very strongly pleochroic, from faint blue to bright smalt-blue. Dumortierite could not be observed without the aid of the microscope. Bundles of radiating needles of sillimanite are occasionally met. Zircon occurs rarely. Secondary hematite is at times conspicuous.

Pyrogenic character of the corundum.—Corundum is described by W. G. Miller[1] in granitoid rocks over wide stretches in the province of Ontario, Canada. It is present in syenite, in nephelite syenite, and in anorthosite. Professor A. C. Lawson has given the name plumasite to a dike rock made up of oligoclase and corundum from Plumas County, California.[2] The granite of Nannie's Mountain, near Yorkville, S. C., carries corundum.[3] Morozewicz describes the occurrence of corundum in pegmatite in the Ural Mountains, intergrown with orthoclase,[4] and again as standing in the place of quartz in granite at Mikolskaja Ssopka, Ural Mountains, Siberia. He names this rock corundum syenite, and declares his belief that corundum occurs in these rocks as an original pyrogenic constituent.

The remarkable occurrences of large amounts of corundum in close association with peridotite in North Carolina have been described by Dr. J. H. Pratt and Professor J. V. Lewis.[5] The view is held by these writers that much of the corundum in this association is an original constituent of the rock. The distribution of the corundum with reference to the peridotite masses is (1) peripheral, along the contact between the peridotite and gneiss; (2) in the peridotite masses in banded veins containing, besides corundum, the minerals chlorite, clinochlore, spinel, and enstatite; and (3) corundum occurring alone, inclosed by peridotite (dunite) at the Hayes Mine, Yancey

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[1] W. G. Miller, "Economic Geology of Eastern Ontario," *Seventh Report, Ontario Bureau of Mines*, 1897 (Toronto, 1898), p. 213. See also W. G. Miller, "The Corundum Bearing Rocks of Eastern Ontario, Canada," *American Geologist*, Vol. XXIV (1899), p. 276.

[2] A. C. Lawson, "Plumasite, an Oligoclase Corundum Rock near Spanish Peak, Cal.," *Bulletin, Department of Geology, University of California*, Vol. III (1903), pp. 219–29.

[3] J. H. Pratt and J. V. Lewis, *North Carolina Geological Survey*, Vol. I (1905), p. 222.

[4] J. Morozewicz, *T. M. P. M.* Vol. XVIII, p. 215, 1898.

[5] "Corundum and the Peridotites of Western North Carolina." *North Carolina Geological Survey*, Vol. I (1905).

County, N. C. Such an association as that last mentioned, (3), was observed in but one locality. Here it is quite possible, in the light of the experiments made by Morozewicz, that the corundum is an original pyrogenic constituent, as suggested by Dr. Pratt. The other occurrences, (1) and (2), can hardly be regarded as anything but secondary alteration products in veins. They show at times a remarkable banded structure, and they are made up largely of the minerals of alteration.

T. H. Holland[1] in the *Geology of India* records the occurrence of corundum in a variety of rocks. While he states that the occurrence of this mineral "as a constituent of normal lavas in the form of tabular crystals characteristic of those obtained artificially by Morozewicz during the devitrification of a slag leaves no doubt as to the possibility of its free crystallization from an igneous magma, as is admitted for other simpler though commoner oxides," he does not admit that the occurrences which have come under his observation are other than accidental, in the sense that the excess of Al_2O_3 was contributed from some extraneous source, or influenced by some rock other than the matrix of the corundum. Thus at Karutakalaiyam, in Madras, corundum occurs "in a coarse feldspar rock," but only near its contact with an eleolite-bearing rock rich in Al_2O_3. Corundum in India occurs in association with basic rocks, but near pegmatite dikes; and, according to Mr. Holland, influenced by such intrusions. The occurrence of corundum with sillimanite imbedded in orthoclase in an acid rock near Paparapatti, Madras, is referred to the contact effects of veins of pegmatite on pyroxene granulite.

The pegmatite dike near Canyon City, Colo., does not show any structures in the field pointing to its having been sensibly changed by metamorphic processes. The arrangement of the constituent minerals is not such as we look for in a metamorphic rock like gneiss. The development of the mica plates is not that which we should expect in a schistose rock. Garnet was not observed. The minerals in the pegmatite are essentially those in the granite which is near at hand. In the dike they are not arranged in lines parallel to the walls, as they have been observed to be in pegmatitic veins or dikes filled

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[1] T. H. Holland, *Geology of India*, p. 10.

"by cementation."[1] Bearing in mind that "under proper conditions water and liquid rock are miscible in all proportions,"[2] the criteria for judging between pegmatite dikes which originate by igneous injection, and those in which heated waters play a larger rôle than molten rock, must be chiefly those of structure. The pegmatitic dike in question, by reason of its eugranitic structure in the field, appears to be among those which deal chiefly in molten rock, and are not greatly charged with heated waters. It lies very near the granite mass along Grape Creek. It tapers rapidly as it runs up the ridge. It has sent off occasional stringers into the schist six inches or more in width, sharply marked off, as are injections of igneous rock into fissures in the form of dikes. These observations support the view that the great dike in question is near the igneous end of the pegmatite series. It would appear that the acid magma was in places uncommonly rich in alumina, and that the excess of Al_2O_3 over that required to satisfy the alkalies and lime for the formation of feldspars crystallized as the oxide corundum. The mineral does not appear as a filling of cavities in the pegmatite. Under the microscope it bears the same indigenous aspect as do the other constituents of the rock. No evidence was obtained such as would point to a replacement of pre-existent minerals by the corundum. It is fresh and clear, and does not show itself as an alteration product of some other mineral. There is nothing to make it plain that the corundum has resulted from some other aluminous mineral by dehydration attendant on metamorphism. It is difficult to reconcile its distribution in the rock with the assumption that the Al_2O_3 needed for it was gained by the working-over in the magma of included portions of the wall rock.

Chemical characteristics of the pegmatite.—The calculation of the analyses of persalanes for their norms frequently presents an excess of Al_2O_3 to be referred to corundum. In the corundum-bearing subclasses of persalane are found quartz felsite, granite, quartz keratophyre, the Uralose rocks described by Morozewicz under the names corundum syenite and corundum pegmatite, and the two analyses of kyschtymite falling in the perfelic order Siberare described by the same author. The present occurrence of modal corundum is one in which the rock is much more siliceous than are the rocks above mentioned in the corundum-bearing subclasses of the persalanes. From a quantitative study of its mineralogy it is placed tentatively in the order Columbare of Class I. It is domalkalic. Dumortierite is a basic aluminic silicate, $Al_8Si_3O_{18}$, with a part of the aluminium replaced by boron. It might reasonably be expected, therefore in a siliceous rock rich in alumina, as is the pegmatite vein near Canyon City. Dumortierite has been reported from a pegmatite vein in schist at Harlem, N. Y.,[1] and from Clip, Yuma County, Ariz. It has been found in similar occurrences near Lyons, France, and near Schmiedeberg, Silesia, as well as in gneiss at Tvestrand, Norway. The present occurrence seems to justify the view that for it corundum and dumortierite are original pyrogenic accessory constituents, and that in other igneous rocks these minerals may occasionally play the same part.

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[1] C. R. Van Hise, "Treatise on Metamorphism," *Monograph 47*, U. S. Geological Survey, p. 723.

[2] *Ibid.*

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[1] For a systematic account of the reported occurrences of dumortierite see W. T. Schaller, *Bulletin 262*, U. S. Geological Survey, p. 91.